THE HAIR TRACTS IN MARSUPIALS.

PART II. DESCRIPTION OF SPECIES, CONTINUED.*

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(Plate viii; forty-three Text-figures.)

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In addition to the further species dealt with in the present contribution, supplementary notes, mostly based on fresh material, are recorded of species previously described.

Acknowledgements.

All but a few of the specimens examined belong to the collection of the National Museum, Melbourne. The late Mr. D. J. Mahony, when Director of the Museum, very generously made them available for study. I am indebted to Mr. C. W. Brazenor, Mammalogist at the same institution, for much help on questions of nomenclature. My thanks are tendered also to Dr. A. B. Walkom, Director of the Australian Museum, Sydney, and to Dr. J. Pearson, Director of the Tasmanian Museum, Hobart, for permission to describe several species from the collections under their charge.

The drawings are the work of Mrs. Dorothy Reid.

Registration numbers prefixed with the letters "R" or "C" refer to specimens from the National Museum Collection. The repository of the remaining material is specifically indicated in the text.

Suborder Polyprotodontia.

Family Dasyuridae.

Subfamily Phascogalinae.

Dasycercus cristicauda Krefft. Figs. 1–3.

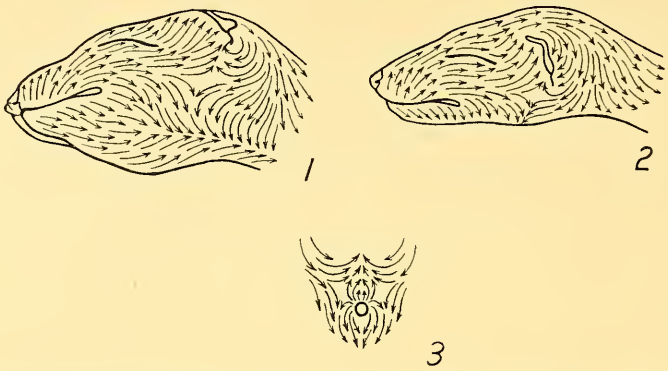
Material.—R.12517–9—three females, and R.12512, R.12521–2, R.12524, R.12528—five males (length of head and body 56–77 mm.); Charlotte Waters, Central Australia.

Wood Jones (1923*b*) says of this species: "The arrangement of the hair upon the whole of the head, body, and limbs is of basal simplicity. The face, head, and the whole of the trunk and tail are clothed with hair having a uniform caudad trend. Upon the limbs the hair is uniformly in a distal and post-axial direction. There are no reversals, partings, convergences, or vortices anywhere." This cannot be said of the series before me which shows some departures from the primitive arrangement.

Head.—On the head dorsally, and laterally above the level of the genal papilla, the hair-flow is mostly caudalwards; between the eye and the ear the current bends upwards so that there the flow is upwards and caudally. Beneath this level on the side of the face, from immediately behind the mystacial zone, the direction is caudalwards and ventrally along an arc which is of shorter radius behind the genal papilla and thus, in a restricted field, the flow is towards the mid-ventral line and at right angles to it; about midway between the genal papilla and the mid-ventral line the flow

* The observations embodied in this paper were made during the tenure of an appointment at the Institute of Anatomy, Canberra, and are published with the permission of the Commonwealth Director-General of Health.

again resumes a caudal and ventralwards trend so that, in all, the current follows a somewhat S-shaped course. Between the mandibles, except in a narrow mid-ventral strip, the hair proceeds caudomedially to coalesce without any definable boundary with the current from the side of the face.



Figs. 1-3.—*Dasycercus cristicauda*. 1. Ventro-lateral view of head and neck (R.12519). 2. Lateral view of head and neck (R.12518). 3. Constituent currents of the prescrotal triangle (R.12512). The bilaterally paired convergent intervals are exaggerated for purpose of illustration.

Neck.—The stream flowing caudalwards over the crown of the head is continued without interruption along the dorsum of the neck and trunk. On the side of the neck the trend is towards the mid-ventral line with varying degrees of obliquity—caudoventrally where it runs on to the lateral aspect of the upper arm over the shoulder and the root of the neck, at right angles to the long axis at about the middle of the neck, cranioventrally in front of this; round the base of the auricle a recurved course is followed. The recurved stream behind the base of the auricle encounters below the stream from the side of the face and where these two opposing currents meet a divergent interval is formed which lies immediately beneath and somewhat in front of the ventral limit of the base of the ear. A mid-ventral convergent line is present on the neck; it extends from about opposite the angle of the mandible along the neck and on to the cranial fourth of the thorax.

Trunk.—The primitive arrangement holds throughout except for the presence in the male of a prescrotal reversed area (*v. infra*). On the ventral trunk the hair flows caudally and medially but the medial component is too weak to produce a mid-ventral line of convergence. The pouch area does not interrupt the direction of hair-flow.

The prescrotal reversed area of the male is similar to that recorded for *Antechinus maculatus* (Boardman, 1943*b*). Its relationship to the scrotal stalk and the currents entering into its formation are detailed in Fig. 3. This reversal is observable satisfactorily only on specimens such as R.12512 in which the fur is well grown. A contribution to the tuft-like convergent centre at the apex of the triangle is made by a sharp recurving of the hairs forming its sides.

Limbs.—The primitive arrangement prevails except on the forearm where, proximal of the ulnar-carpal vibrissae, the hair on the lateral and medial aspects of the limb bends back to produce a reversed stream which flows along its postaxial margin to end in a convergent centre just distal of the elbow. In the axilla a divergent interval is formed similar to that figured for *Cercartetus nanus unicolor* (Fig. 14).

Remarks.—The close resemblance of this species to *Antechinus maculatus* should be emphasized. The only noteworthy differences are the presence of a forearm reversal in *Dasycercus cristicauda*, and a relative weakness in the recurved stream behind the base of the ear in *Antechinus maculatus* which has prevented the formation of a clearly defined divergent interval.

DASYUROIDES BYRNEI Spencer.

Material.—C.465–7—a male and two females (length of head and body 57–75 mm.); Central Australia.

No significant differences from *Dasycercus cristicauda* could be defined.

SMINTHOPSIS CRASSICAUDATA CENTRALIS Thomas.

Material.—R.12461—two specimens, a male and a female, probably litter mates (crown-rump length about 24 mm.); Charlotte Waters, Central Australia.

Like the subspecies *macrura* (Boardman, 1943*b*), *centralis* shows no differences which are detectable (on the developmental stage available) from *Antechinus maculatus*. The hair of the inguinal region is weakly developed, but the prescrotal reversed triangle can readily be charted.

Subfamily DASYURINAE.

DASYURINUS GEOFFROII GEOFFROII Gould.

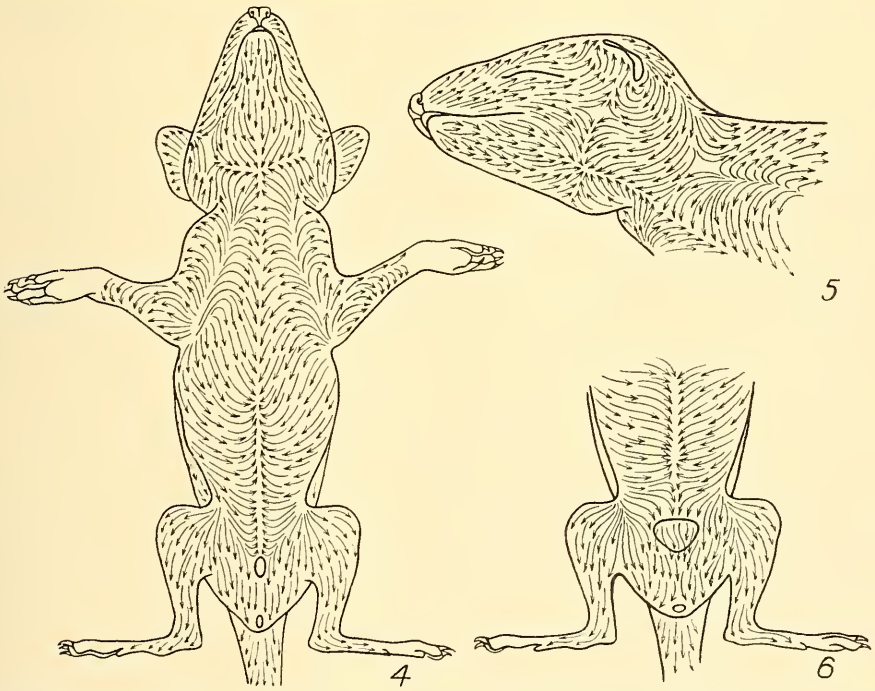
Material.—C.476–8—three litter mates comprising a male and two females (crown-rump length about 59 mm.); Central Australia.

The principal difference between the subspecies *geoffroii* and *fortis* (*v. infra*) occurs in the females. In the female of *geoffroii* the mid-ventral inguinal convergent interval lies immediately in front of the cranial limit of the pouch (cf. Fig. 6). The males of the two subspecies are similar in every respect.

DASYURINUS GEOFFROII FORTIS Thomas. Figs. 4–6.

Material.—R.1931–2—a male and a female (length of head and body 117 mm.); Western Australia; October, 1875.

Head.—In this animal the head corresponds point for point with the condition described above for *Dasycercus cristicauda*, except that the divergent interval below the base of the ear is not so precisely defined.



Figs. 4-6.—*Dasyurinus geoffroii fortis*. 4. The male from the ventral aspect. 5. Ventro-lateral view of head, neck and upper thorax. 6. Abdomen of the female viewed ventrally.

Neck.—The flow of hair on the dorsum, sides, and cranial two-thirds of the ventral aspect of the neck is very much the same as described for *Dasycercus cristicauda.* On the ventral surface in its caudal third, however, there is some difference due to disturbance on the upper chest; this area will be referred to below.

Trunk.—A divergent centre is situated within the axilla and from it hair flows laterally on to the medial aspect of the forearm, medially by a curved course (concave caudally) on to the ventral chest, and in front towards and across the cranial axillary fold and so by recurvature on to the lateral aspect of the upper arm. A weak feathering, which takes its origin in the divergent centre, runs forward, inclined towards the medial line, to about the middle of the neck; medially from it hair flows along a curved course towards the mid-ventral line, laterally by a similar curved course over the root of the neck on to the shoulder and front of the arm where it merges with the general caudalwards current of the side of the body. The details of the relationships of these currents are illustrated in Figs. 4 and 5.

On the dorsal and lateral aspects of the trunk the hair-flow is primitive. In both the male and the female the current over the flanks curves round sharply towards the mid-ventral line. In the male the bending round becomes a recurvature which results in the formation of a convergent centre about midway between the attachments of the limbs; a convergent centre is not formed in the female, but instead there is a distinct hair-ridge which stops short caudally at a convergent interval in front of the pouch area. The tracts of the inguinal region are primitive in both sexes; a prescrotal triangle is present in the male.

Limbs.—A forearm reversal occurs as in *Dasycercus cristicauda* but with the convergent centre more distally placed.

Dasyurops maculatus Kerr.

Material.—C.441–3—two males and a female, probably litter mates (length of head and body 102 mm.); Western Australia; purch. W. Groener, 30th April, 1880.

The male is similar in every way to *Dasyurinus geoffroii fortis.* The female shows no differences from the female of the subspecies *Dasyurinus geoffroii geoffroii.*

Sarcophilus harrisii Boitard. Figs. 7 and 8.

Material.—R.5459–5462—a group of four females (length of head and body in each case 135 mm.); Wynyard, Tasmania; 20th July, 1914.

The general features of the disposition of the hair tracts in this species have already been described (Boardman, 1943*b*). The present series of four females is ideal for figuring and enables the previous description to be amplified by the provision of a diagram of the hair arrangement of the ventral abdomen and in the gular region and axilla. It will be noticed that the mid-ventral convergent centre on the trunk is whorled in a clockwise direction. A re-examination of the male (A.6438, Australian Museum Collection) shows that the scrotal stalk has the same relations to the inguinal convergent interval as has the pouch in the female.

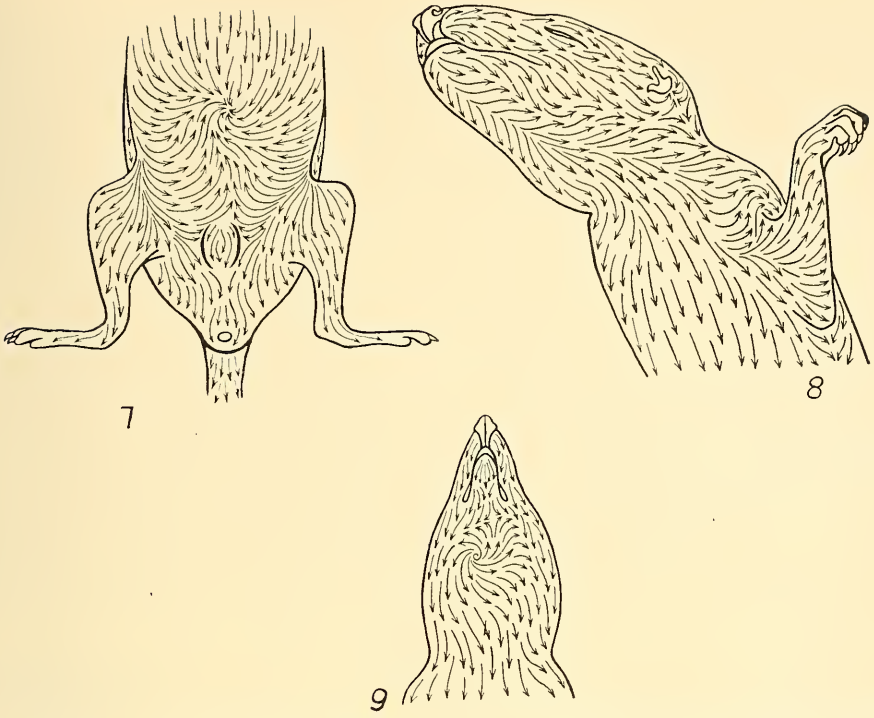
Family Peramelidae.

Isoodon obesulus obesulus Shaw and Nodder. Fig. 9.

Material.—C.451—a female (length of head and body 111 mm.); Central Australia.

The features shown by the subspecies *obesulus* differ from *fusciventer** only in detail in the zone where the forward flow from the gular whorl system meets the backward flow from the chin. This will be clear from a comparison of Figs. 9 and 10. The gular whorl is single, on the right side, and counter-clockwise; its influence cranially ceases immediately behind the interramal papilla.

* Specimens of *Isoodon obesulus* described (Boardman, 1943*b*) without subspecific designation are, by virtue of their locality, almost certainly the subspecies *fusciventer.* The arrangement of hair on the throat between the mandibles is the same as that recorded and figured for *Perameles gunnii* (this communication, Fig. 10).



Figs. 7 and 8.—*Sarcophilus harrisii.* 7. The female abdomen from the ventral aspect. 8. Ventro-lateral view of the head, neck and thorax.
Fig. 9.—*Isoodon obesulus obesulus.* The gular field.

PERAMELES GUNNII Gray. Figs. 10–13.

Material.—C.589—a female (length of head and body 133 mm.); locality unknown; pres. Zoology and Acclimatization Society of Victoria, 1st June, 1872. C.590—a male (length of head and body 123 mm.); Victoria; coll. D. Le Souef. R.12634—a female (length of head and body 128 mm.); Victoria; 15th November, 1920. R.13042—a female (length of head and body 147 mm.); Kew, Victoria; 14th September, 1886.

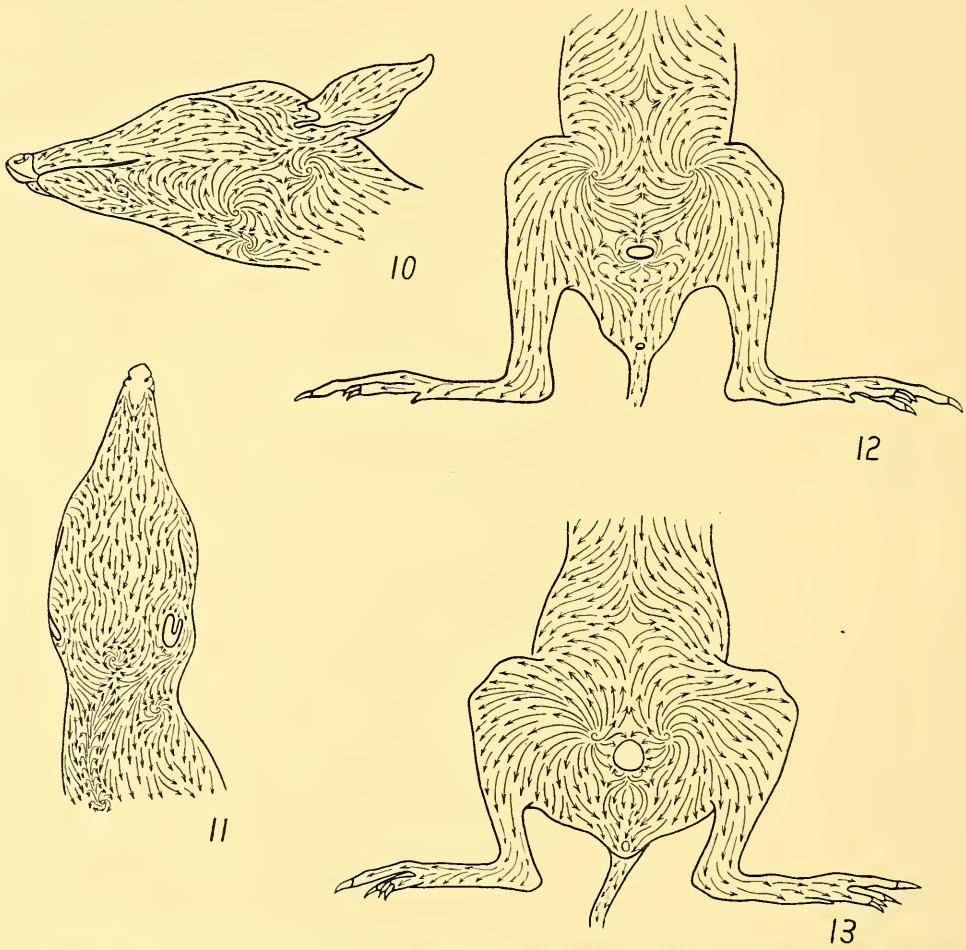
Head and Neck.—Of the three females examined two have a pair of gular whorls as in *Perameles nasuta* (Boardman, 1943*a*), one a single clockwise whorl on the left side like the male of *Isoodon obesulus fusciventer* (see footnote, p. 182); the arrangement of hair currents between the mandibles is the same for both the females and the male. The male presents so many abnormal features that it is considered separately below.

Trunk.—The general arrangement of the trunk currents is as described and figured for *Isoodon obesulus fusciventer* (Boardman, 1943*b*, Fig. 9) but a complication is introduced in that the inguinal reversal has its origin in a pair of symmetrically disposed whorls, the left member being clockwise, the right counter-clockwise. In the female the centres of the whorled system lie about level with the cranial limit of the pouch and only a short distance from the mid-ventral line. In the male the centres are relatively more widely separated and so much further cranially that they lie medial of the knee.

Limbs.—None of the specimens shows any signs of forearm reversal. On the contrary there is along the postaxial margin a well-marked flow running distally.

Abnormality.—The single male (C.590) of the series has bilateral gular whorls, somewhat nearer to the medial line than usual, but otherwise normal. In addition, there are irregularities in the disposition of the currents on the head, neck and thorax.

A supernumerary clockwise whorl is present on the left side beneath the base of the ear. There is a small counter-clockwise whorl on the dorsal neck immediately behind the occiput and to the left of the middle line; an imperfect clockwise whorl occurs dorsally on the thorax, to the left of the middle line and approximately opposite to the middle of the attachment of the fore-limb; a further clockwise whorl is present on the right side just behind the shoulder. These anomalous whorls and the interplay of the territories associated with them are charted in Figs. 10 and 11. An additional imperfect clockwise whorl (not shown in the figures) is formed laterally on the right side of the thorax behind and somewhat above the level of the axillary fold; its field of disturbance is very restricted.



Figs. 10-13.—*Perameles gunnii*. 10. Face and gular field of C.590. 11. Dorsal view of head, neck and thorax of C.590. 12. The ventral abdomen in the male. 13. The ventral abdomen in the female.

Macrotis minor minor Spencer.

Material.—C.593—a female (length of head and body about 86 mm.); Charlotte Waters, Central Australia; pres. W. B. Spencer, 23rd April, 1896. R.12431—a male (length of head and body about 82 mm.), R.12432—a female (length of head and body about 86 mm.); same locality; September, 1895.

Unfortunately these specimens have not the hair sufficiently developed for a full account of the hair tracts to be given. Each of the females has a single clockwise

gular whorl on the left side and a reversal of the usual type on the postaxial margin of the forearm. A gular whorl and forearm reversal are absent in the male. The disposition of the tracts in the inguinal region of the female is similar to the account given of *Perameles myosura notina* (Boardman, 1943*b*). In the male the inguinal tracts are too obscure for comment.

Suborder Diprotodontia.
Family Phalangeridae.
Subfamily Phalangerinae.
Acrobates pygmaeus Shaw.

Material.—R.8139—two males and a female, litter mates (crown-rump length about 33 mm.); Meenyan, Victoria; February, 1895. R.12685—a male and a female, litter mates (crown-rump length 40 mm.); Victoria; 14th May, 1906.

The primitive nature of the hair currents as recorded earlier (Boardman, 1943*b*) is confirmed. The flying membrane, at this stage rudimentary, does not interfere with the primitive ventro-caudal flow over the side of the body between the attachments of the limbs.

The scrotum, which is flattened transversely, is attached to the body not by a narrow stalk but by a broad base as wide as the scrotum's greatest width. In front of the sessile scrotum the caudally and medially flowing hairs on the ventral abdomen stop short, leaving an almost naked triangular patch having a base as wide as the scrotal base and a height about half the length of the base; the triangle constitutes an area of reversal and is formed in the same manner as in the Phascogalinae.

Cercartetus nanus nanus Desmarest.

Material.—R.13003—a male and two females, litter mates (crown-rump length 26 mm.), R.13012—two males and two females, litter mates (crown-rump length 34 mm.); Tasmania; 20th September, 1872.

The subspecies *nanus* is similar in every way to *unicolor* (*v. infra*).

Cercartetus nanus unicolor Krefft. Fig. 14.

Material.—C.793–4—two males, litter mates (crown-rump length 33 mm.); Mordialloc, Victoria; pres. A. Campbell, 5th October, 1887. C.791—three females, litter mates (crown-rump length 30 mm.); Mallee, Victoria; pres. A. Mattingly, 28th September, 1910.

Head.—On the dorsum of the head and neck the hair current sweeps caudalwards on to the back. The lateral aspect of the head shows a considerable disturbance of the normal backward hair-flow which is centred round a quadrilateral divergent interval lying immediately behind the genal papilla. A strong preauricular current sweeps upwards and recurves round the base of the ear so that it is completely encircled. Where the current sweeps round the base of the ear below and encounters the normal caudalwards flow on the side of the face beneath the eye, the divergent interval referred to above is formed. As a consequence, the stream on the side of the face above the genal papilla bends so that its course is upwards and caudally and merges with the preauricular stream; the hair deflection below the divergent interval results in a curved flow towards the mid-ventral line. In the vicinity of the chin the hair flow is caudalwards; further back towards the angle of the mouth the flow gets progressively more and more towards the mid-ventral line and behind merges with the currents sweeping round from the side of the face.

Neck.—Caudal of the recurvature round the base of the ear the arrangement of the currents on the neck is similar to that described above for *Dasycercus cristicauda.*

Trunk.—The primitive arrangement prevails except in the axilla where a divergent interval occurs just within its caudal fold, that is, opposite to the elbow. From this divergent interval hair flows distally along the forearm and medially and caudalwards on to the chest.

It is worthy of record that the scrotum is similar to that described in *Acrobates pygmaeus* and is similarly associated with a prescrotal reversed triangle.

Limbs.—The hair currents on the limbs are entirely primitive.

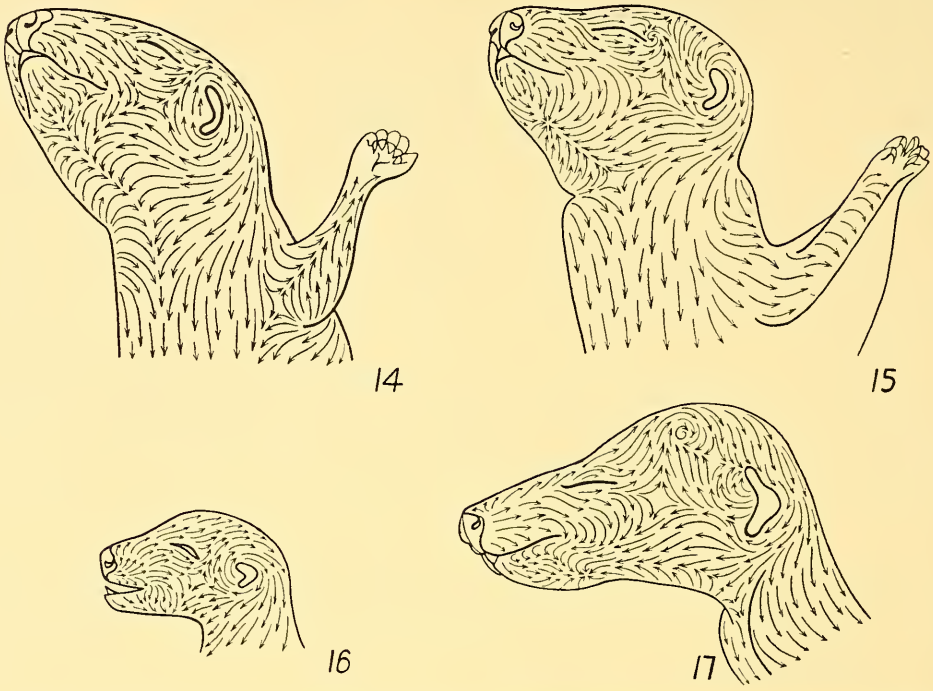


Fig. 14.—*Cercartetus nanus unicolor.* Head, neck and upper thorax in ventro-lateral view.
Fig. 15.—*Petaurus breviceps.* Head, neck and upper thorax in ventro-lateral view.
Fig. 16.—*Petaurus papuanus.* Lateral view of head and neck.
Fig. 17.—*Pseudocheirus laniginosus.* Lateral view of head and neck.

PETAURUS AUSTRALIS Shaw and Nodder.

Material.—A male and a female (length of head and body 100 mm. and 96 mm. respectively); no data (Australian Institute of Anatomy Collection).

This species shows no differences from *Petaurus breviceps* (*v. infra*).

PETAURUS NORFOLCENSIS Kerr.

Material.—M.3783 and M.3785—two males (crown-rump length about 57 mm.); Cooroomon, Rockhampton district, Queensland; pres. H. C. McCartney (Australian Museum Collection).

The hair on these two specimens is not sufficiently developed for detailed charting except on the head, where it corresponds point for point with the account given below for *Petaurus breviceps.* On the rest of the body comparison with *Petaurus breviceps* shows that it is unlikely that any major differences from that species are present.

PETAURUS BREVICEPS Waterhouse. Fig. 15.

Material.—R.12536–7—two males (length of head and body 90 mm.); Cape York, Queensland; June, 1897.

Head.—The hair tracts on the head are practically identical with those described above for *Cercartetus nanus.* Minor differences are mostly due to a single factor—the greater field of influence of the preauricular stream which, in this species, sweeps forward beyond and above the lateral angle of the eye and forms with the caudally

flowing current of the dorsum of the head a short hair-ridge with a divergent interval at about its middle. Consequent upon the presence of a convergent interval on the throat (*v. infra*) the currents on the ventral aspect of the head converge on a point in the mid-ventral line and just caudal of the level of the angle of the mouth.

Neck.—Generally, the neck is reminiscent of that described and figured above for *Cercartetus nanus* but differs in the presence of a convergent interval midventrally at about its middle.

Trunk and Limbs.—The hair on the trunk follows the pattern described for *Schoinobates volans* (Boardman, 1943*b* and Fig. 18 below). Little doubt exists that in specimens with the hair more advanced a triangular prescrotal reversal would be detectable.

Petaurus papuanus Thomas. Fig. 16.

Material.—M.6379–80—two males (crown-rump length about 55 mm.); Bulolo, Morobe Division, Territory of New Guinea; pres. Dr. C. E. M. Gunther (Australian Museum Collection).

The species agrees with the account of *P. breviceps* given above except in the vicinity of the lateral angle of the eye. This difference will be apparent from a comparison of Figures 15 and 16.

Pseudocheirus laniginosus Gould. Fig. 17.

Material.—C.599—a male (crown-rump length 75 mm.); Gippsland, Victoria; pres. K. Flatow, 1st November, 1886.

Head and Neck.—The condition of the hair tracts on the head and neck is reminiscent of what has been described above in *Petaurus breviceps*. The presence on the dorsum of the head, above and somewhat in front of the ears, of bilaterally paired centrifugal coils immediately distinguishes the genus (see also *P. convolutor* below). The relationship of the coil to the hair-ridge into the formation of which it enters and which runs between it and the base of the ear is shown in Fig. 17; there is a convergent interval on the ridge at its middle.

Trunk.—The trunk currents are primitive in their arrangement. Midventrally a convergent line is present between the inguinal folds and thighs in front of the scrotum. A naked triangle which probably signifies the presence of a prescrotal reversal occurs in the usual position in front of the scrotum.

Limbs.—No interruptions of the primitive disposition occur.

Pseudocheirus convolutor convolutor Oken. Plate viii.

Material.—No. 11, Pearson Collection (Tasmanian Museum)—a male (crown-rump length 74 mm.); no data.

The growth of hair in this specimen is somewhat short of ideal requirements but the principal features are well defined.

Head and Neck.—The condition of the hair tracts on the head is very similar in general to that described and figured for *P. laniginosus* (*v. supra*). The divergent interval on the side of the face lies immediately behind the genal papilla. The recurved current at the back of the base of the ear bends sharply round it ventrally, and where the current encounters the lower part of the preauricular reversal, a short forwardly directed hair-ridge is formed. Bilaterally paired centrifugal coils occur as in *P. laniginosus* and have the same relationships to the ear base and associated hair-ridge.

The same arrangement as in *Dactylopsila picata* (Boardman, 1943*b*) is found immediately behind the rhinarium, but in this case the reversed area is more definite and there is on the mid-dorsal line behind it a potential convergent interval caused by the bending backwards of the hairs behind the level of the middle of the dorsal border of the mystacial zone.

On the dorsum of the neck the hair-flow is caudalwards; laterally it follows the plan which is general in the group when a recurved current runs round the back of

the base of the ear. There is a convergent interval midventrally on the neck as figured for *P. laniginosus*.

Trunk and Limbs.—No departures from the primitive arrangement are present. The hair on the flanks is sparse, flows ventrally and caudally, but there is no mid-ventral line of convergence developed at this stage. A prescrotal reversed triangle occurs in association with a male pouch (Plate viii).

There is no axillary reversal; a divergence of the caudally flowing stream on the ventral chest flows across the axilla and so on to the medial aspect of the arm.

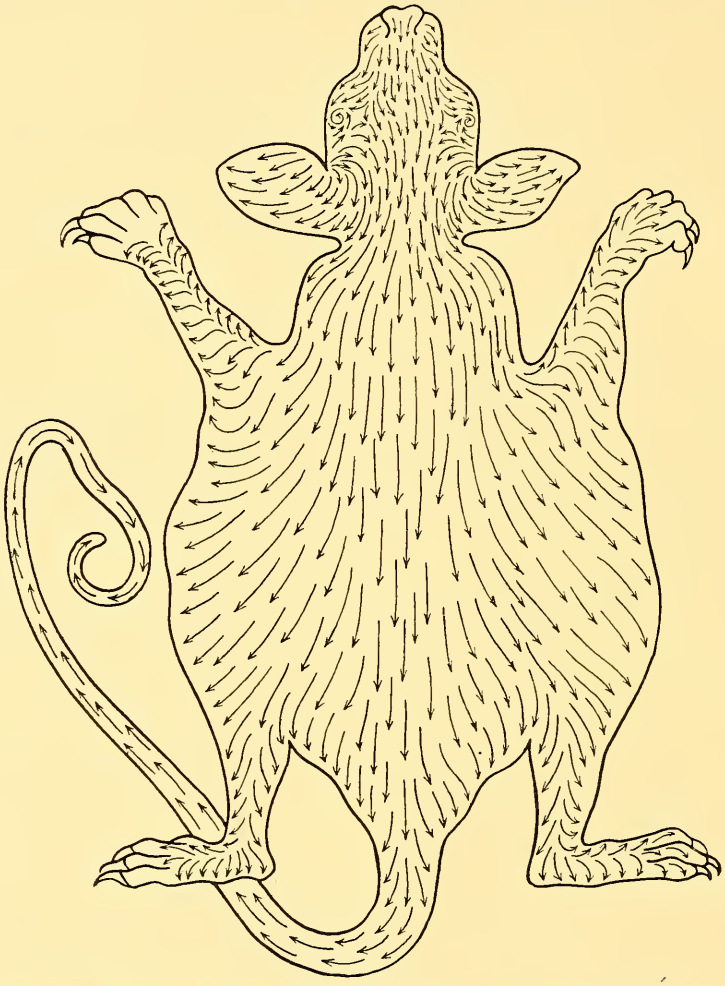


Fig. 18.—*Schoinobates volans*. Dorsal view of entire animal with flying membranes spread out.

SCHOINOBATES VOLANS Kerr. Fig. 18.

The previous account of this series (Boardman, 1943*b*) is augmented by the provision of a figure of the dorsal surface of the body. The drawing is from specimen M.3036 (Australian Museum Collection).

TRICHOSURUS VULPECULA VULPECULA Kerr. Figs. 19 and 20.

Material.—A male (crown-rump length 101 mm.); pres. W. Eldridge, 18th February, 1944. A male (crown-rump length 99 mm.); pres. R. N. Wardle, 20th March, 1944. A male (crown-rump length 109 mm.); pres. W. Eldridge,

15th July, 1944. These three males were all collected in Canberra, Australian Capital Territory. In addition, there is a female (crown-rump length 90 mm.) and a male (length of head and body 220 mm.), both from Canberra but having no further data. The series is in the Australian Institute of Anatomy Collection.

Wood Jones (1920) has already provided an account of the hair tracts in this species under the name *Trichosurus vulpecula* var. *typicus*. The material used by him included specimens from both the South Australian and the Western Australian Museums. It would appear probable that not all of his material is referable to the typical form the distribution of which is defined in Iredale and Troughton's check-list (1934). The following account, based on the 220 mm. male, is to be regarded as supplementary to that of Wood Jones.

Figs. 19 and 20.—*Trichosurus vulpecula vulpecula*. 19. Lateral view of head and neck. 20. Ventral aspect of the entire animal. Both figures are based on the 220 mm. male which apparently early in life lost the right hind-limb.

The specimen is, in the arrangement of its hair tracts, very similar to what has been recorded by Wood Jones. Differences in detail, however, are sufficient to merit the provision of a comparable figure of the face in side-view. It will be noticed that there is no clear demarcation in the form of a hair-ridge between the areas marked A and B by Wood Jones; also, there is no hair parting between the areas B and C. The reversal in front of the eye which contributes largely to the territory B takes its origin in the present series in what might be described as a divergent centre at the

medial angle of the eye (cf. Wood Jones' Fig. 2). Hairs streaming forward from this centre encounter along the upper portion of the caudal margin of the mystacial zone a stream flowing upwards and caudally, with the result that a hair-ridge is formed with a divergent interval at about the middle of its length. Immediately above the divergent interval which results from the impact of the sub-ocular stream on the reversed current which flows from behind the ear there is on each side a small whorl.

The radiating centre recorded by Wood Jones as situated between the ears is in all of the present series a clockwise whorl.

Wood Jones makes no reference to the disposition of the hair tracts on the ventral surface. What he refers to as "the general line of convergent streams (which) runs downwards and forwards over the cheek and to the lower jaw near to its angle" is continued towards the mid-ventral line where the convergent stream line (in this specimen it should rather be called a ridge) joins its fellow mid-ventrally just behind the interramal papilla, the point of meeting being marked by a small clockwise centripetal whorl. In the axilla a whorl is present on each side situated just within the free border of the caudal fold; it is clockwise on the left, counter-clockwise on the right. As a result of the hair reversal which originates in the axillary whorl, a ridge including a divergent interval is formed on the medial aspect of the upper arm. On the side of the body between the limbs the current flows caudally and ventrally; a mid-ventral convergent point is present in the form of a tuft with a suggestion of clockwise centripetal whorling. As is usual, a well-defined convergent interval occurs in the mid-ventral line just in front of the scrotum; there is no prescrotal reversed triangle. The mid-ventral line is indicated by a hair-ridge only behind the abdominal tuft.

Variation.—In none of the remaining specimens is the sub-ocular divergent interval and its associated whorl present. Sometimes a distinct mid-ventral hair-ridge is formed on the upper chest especially along the area occupied by the sternal gland.

Trichosurus vulpecula hypoleucus Wagner.

Material.—C.600—a female (crown-rump length 80 mm.); Claremont, Western Australia; pres. H. J. Coles, 3rd October, 1911.

The hair is at a too early stage of growth for detailed charting except on the head. The condition on the face is similar to that described for individuals of the subspecies *vulpecula* (*v. supra*) in which the divergent interval beneath the eye is not present; in this respect the specimen differs also from Wood Jones' Western Australian Museum example which formed the basis of his description and was most probably from a Western Australian locality. A divergent centre occurs on the crown between the ears as described by Wood Jones.

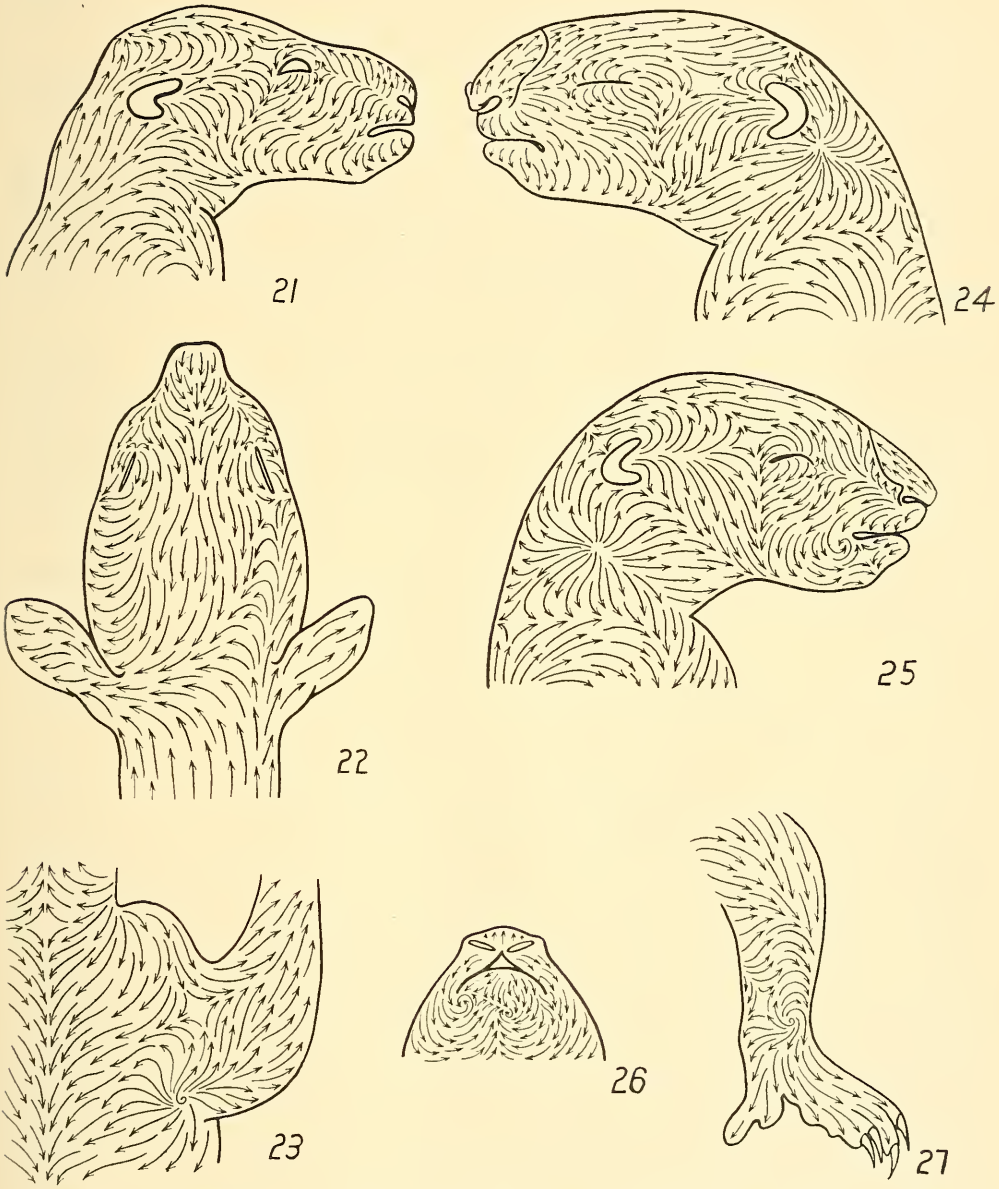
Trichosurus fuliginosus Ogilby.

Material.—No. 10, Pearson Collection (Tasmanian Museum)—a male (length of head and body 225 mm.); Mt. Wellington, Tasmania; 17th March, 1943. C.602—a male (crown-rump length 83 mm.); Tasmania; purch. Castleman, 1863.

The Tasmanian Museum male is at a very satisfactory stage for describing the hair tracts. Its only difference from *Trichosurus vulpecula vulpecula* (sub-ocular divergent interval absent) lies in the arrangement of the hair streams on the crown. Two counter-clockwise whorls (the whorling is not very marked) are present, one behind the other in the mid-dorsal line; the more cranial of the two is situated at the vertex some little distance in front of the line joining the bases of the ears in front and is produced into a feathering before and behind; the second is situated directly between the bases of the ears and is associated with similar featherings. Midway between the two whorls a divergent interval is produced where the opposing streams meet. In so far as the disposition of hair streams in their vicinity is concerned these two whorls have together the same effect as the single whorl or divergent centre described elsewhere in the genus.

A convergent ridge occurs along a line running obliquely across the back of the thigh from behind the knee to the mid-ventral line which it reaches at a point about two-thirds of the distance from the base of the scrotum to the base of the cloacal hillock. It is formed by the stream on the lateral aspect of the thigh bending round its postaxial margin and recurving proximally with respect to the limb before merging with the stream on the medial aspect of the thigh.

Variation.—The hair is only weakly developed on the specimen C.602, but as far as can be ascertained the tracts agree with those of the example just described except



Figs. 21-27.—*Phascolarctos cinereus.* 21. Lateral view of head and neck (C.433). 22. Head and neck from above (C.433). 23. Axilla, thorax and root of neck (stage H). 24 and 25. Lateral view of head and neck from the left and right respectively (stage H). 26. The mental zone (stage H). 27. Left hind-limb showing the whorl just above the ankle (stage H).

in one particular—the absence of the caudal member of the pair of whorls on the vertex.

Family Phascolarctidae.

Phascolarctos cinereus Goldfuss. Figs. 21–27.

Material.—C.604—a male (crown-rump length 92 mm.); no data. C.603—a female (crown-rump length 103 mm.); no data. C.433—a male (crown-rump length 112 mm.); Victoria; pres. Zoology and Acclimatization Society of Victoria, 5th June, 1901.

All three examples of the species appear to coincide generally with Wood Jones' original account (1923*a*), but only C.433 has the hair sufficiently developed for detailed charting. Each has a single counter-clockwise whorl between the shoulders.

C.433 differs from the individual examined by Wood Jones in that there is no whorl on the front of the hind-limb just above the ankle. This specimen also displays an abnormality on the right side of the head (see below and Figs. 21 and 22).

It cannot be said with certainty whether or no C.603 and C.604 possess a whorl on the front of the hind-limb owing to the weak development and sparseness of the hair. Considering, however, the irregularity of hair inclination on the site where the whorl normally occurs, it would seem likely that the whorl would have developed in each case.

No reference has previously been made in the literature to the arrangement of the hair streams on the ventral surface. The typical phalangerine arrangement prevails. Axillary whorls are present (Fig. 23).

My previous supplementary account (Boardman, 1943*a*) of the species was based, for the most part, on a specimen designated "H" in the collection of the Australian Institute of Anatomy. As a result of re-examination of this individual emended figures are submitted (Figs. 24 and 25) of the hair streams on the sides of the head. The right side of the head of this specimen is not symmetrical with the left, an arrangement which was previously dismissed as an artefact. A variation of similar type on the right side of C.433 (Figs. 21 and 22), however, leaves little doubt that it is an abnormality.

A figure is also submitted of the whorl on the hind-limb and the condition of the hair streams on the chin; both drawings are from specimen "H".

Family Vombatidae.

Vombatus ursinus ursinus Shaw. Fig. 28.

Material.—R.4949—a female (crown-rump length 155 mm.); Flinders Island, Bass Strait; 11th November, 1909.

Head, Neck and Trunk.—Disturbances to the primitive flow of hair are, for the most part, traceable to a pair of whorls one on each side of the mid-ventral line opposite a point a little above the middle of the humerus. The left whorl is clockwise, the right counter-clockwise. From the level of the centres of the whorls caudally for a short distance a hair-ridge is formed lying somewhat obliquely with reference to the longitudinal axis; it terminates in a small convergent interval. The effect of the presence of the whorls on the hair flow of the gular region is to produce a reversal in the form of an extensive mid-ventral feathering. From this feathering and the associated whorls hair streams on a recurved course across the upper arm, the shoulder, and the side of the neck and face. The feathering terminates in front of the interramal papilla where it forms in the mid-ventral line a small divergent interval where contact is made with the caudally and laterally flowing current on the chin. The chin current merges insensibly with the recurved flow at the cranial limit of the feathering thus contributing to the general caudalwards current on the side of the face. The facial current is divided by the ear around which it sweeps above and below to rejoin behind, thence to continue straight back along the short neck. Immediately in front of where these streams unite behind the base of the ear a strong recurvature of hairs both from the dorsal and ventral components provides the hairy covering on the medial aspect of the auricle and produces a small convergent interval behind the ear base.

Caudal of the centre of the bilateral thoracic whorls hair streams on to the medial aspect of the arm, into the axilla, and towards the mid-ventral line of the chest, there to initiate a parting which persists back as far as the pouch. From this mid-ventral parting the hair trend is caudally and dorsally to merge with the currents on the side of the body. Consequent upon the flow away from the medial line the currents in the inguinal region diverge and sweep round the pouch almost meeting behind and then diverge again to surround in similar manner the cloacal hillock. There is some asymmetry behind the pouch (see Fig. 28).

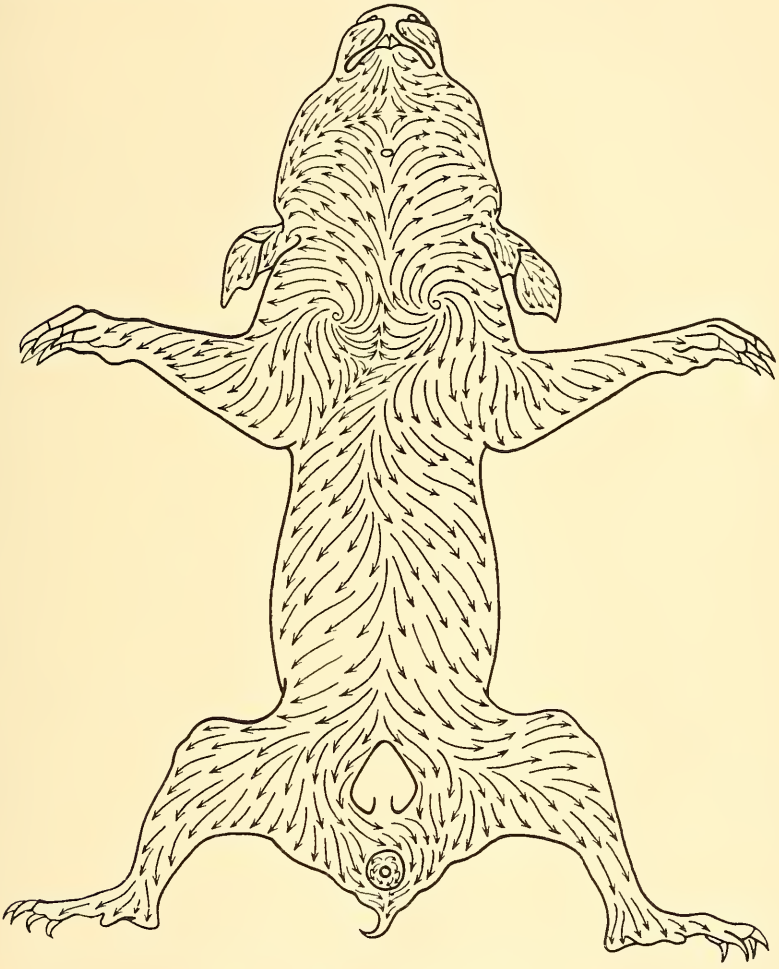


Fig. 28.—*Vombatus ursinus ursinus.* Ventral view of whole animal.

Limbs.—The fore-limb exhibits a peculiarity in that along the postaxial aspect of the forearm the postaxially or postaxially and distally flowing current on the lateral and medial faces of the limb bends sharply towards its extremity to produce a broad distally flowing stream. A somewhat similar situation occurs on the shank of the hind-limb, but since the current on the medial surface is already flowing distally, only the flow on the lateral surface is involved in the distal bending. On the postaxial margin of the thigh a hair-ridge occurs brought about by the meeting of the currents from its medial and lateral surfaces; at about the middle of this ridge a small convergent interval is produced by a hair disposition such that proximal of the interval

a stream flows towards the root of the limb, and on the opposite side of it a stream flows distally.

VOMBATUS URSINUS TASMANIENSIS Spencer and Kershaw. Fig. 29.

Material.—No. 22, Pearson Collection (Tasmanian Museum)—a female (length of head and body about 340 mm.); Eaglehawk Neck, Tasmania; 27th October, 1939.

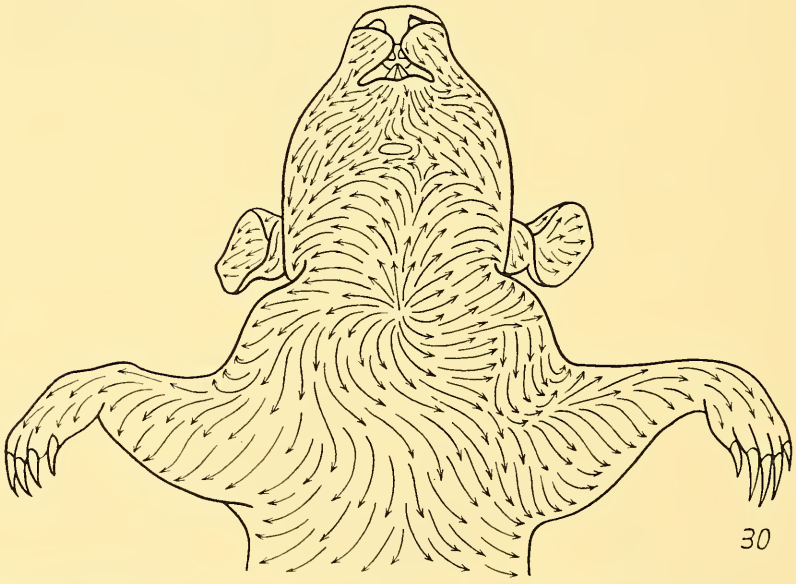


Fig. 29.—*Vombatus ursinus tasmaniensis.* Ventral aspect of the head.
Fig. 30.—*Vombatus hirsutus hirsutus.* Ventral view of head, neck and thorax.

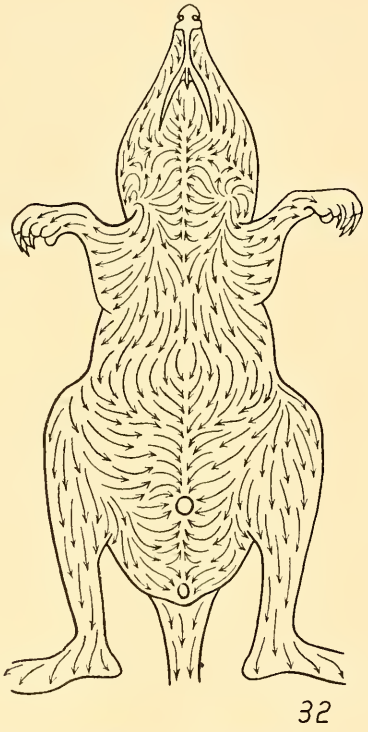
Wood Jones (1924) has discussed the hair tracts in the Tasmanian member of the genus and recorded that they showed no deviation from the primitive arrangement in any part. The single specimen available to me does not support this view.

Unfortunately this very fine individual from the Pearson Collection has been extensively dissected from the ventral surface whereon the main disturbances of the primitive arrangement are found in the genus. There does not seem to be any doubt, however, that the subspecies would be described in similar terms to those used for the subspecies *ursinus*. The region where the paired whorls occur on the upper thorax in the subspecies *ursinus* is in this subspecies damaged, especially on the left side. On the right side a counter-clockwise whorl is present situated on a slightly lower level than in *ursinus*; it would appear that the bilateral pair exists.

Two details in which the subspecies under consideration differs from *ursinus* are worthy of note. In *tasmaniensis* the mid-ventral feathering which runs along the gular region stops short just behind the interramal papilla. The arrangement of hair round the interramal papilla is curiously complicated; it is plotted in Fig. 29 (cf. Fig. 28). A further difference lies in the nearness to the flexure behind the knee of the convergent interval on the hair-ridge lying along the postaxial margin of the thigh.

Vombatus hirsutus hirsutus Perry. Fig. 30.

The previous account (Boardman, 1943*a*) of this form is extended by a figure of the ventral aspect of the head, neck and thorax to facilitate comparison with *ursinus*. The drawing is from specimen "G".



Figs. 31 and 32.—*Potorous tridactylus apicalis*. Lateral and ventral views respectively of the whole animal.

Family Macropodidae.

Subfamily Potoroinae.

Potorous tridactylus apicalis Gould. Figs. 31 and 32.

Material.—Zb2—a male (crown-rump length 105 mm.); Lunawanna, S. Bruny Island, Tasmania; coll. A. W. G. Powell, February, 1936 (Tasmanian Museum Collection).

The hair tracts of one other member of the subfamily Potoroinae have hitherto been described, viz., *Bettongia penicillata* (Boardman, 1943*b*). The present species is similar in type but displays considerable differences in detail which serve clearly to separate the two species.

The bilateral system of divergent centres and partings recorded as occurring ventrally on the thorax and neck of *B. penicillata* is, in the present species, reduced in extent. The divergent centres (they have the facies of diffuse imperfect whorls) are more cranial in position, being situated ventro-laterally on the neck medial of, and on about the same level as, the shoulders. Consequently, the feathering is practically

eliminated since the forwardly directed hairs enter almost immediately into the formation of the divergent interval on the side of the face.

A convergent interval occurs immediately behind the base of the ear. It is produced where the current sweeping caudally along the dorsum of the head between the bases of the ears diverges to join with the caudally and dorsally directed current on the side of the neck. Each of these two major elements provides in front a recurved stream which flows over the medial surface of the auricle, thus completing the interval.

Hair disposition on the trunk does not follow the almost completely primitive plan found in *B. penicillata*. Instead, the currents from the axilla and adjacent lower thorax recurve away from the mid-ventral line and flow dorsally and caudally on the side of the body between the attachments of the limbs. The effects of this arrangement are shown in Figs. 31 and 32. The tracts of the inguinal region are illustrated in Fig. 32; a figure (33) of the inguinal region of *B. penicillata* drawn from the same specimen as the previous figures of the species is added for comparison.

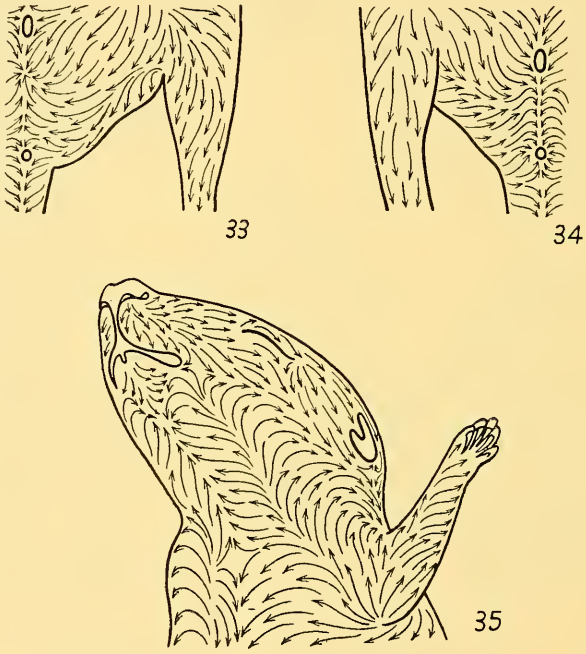


Fig. 33.—*Bettongia penicillata*. Hair tracts of the groin.

Figs. 34 and 35.—*Caloprymnus campestris*. 34. Hair tracts of the groin. 35. Head, neck and upper thorax in ventro-lateral view.

CALOPRYMNUS CAMPESTRIS Gould. Figs. 34 and 35.

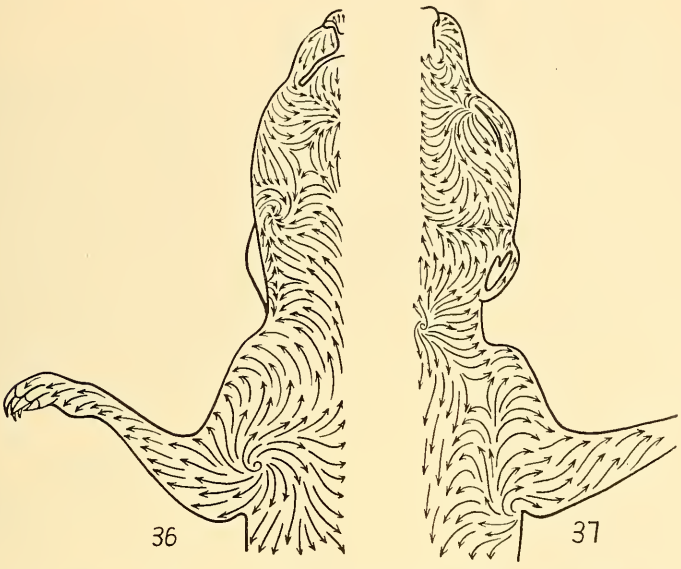
Material.—R.13612—a female, R.13613—a male (both have the length of head and body about 200 mm.); Mulka, South Australia; 6th August, 1932.

Ordinarily, hair development on these specimens would be considered too advanced for charting, but the account available of *Bettongia penicillata* (Boardman, 1943*b*) leaves no doubt of how the tracts should be interpreted; the same ground-plan is found to occur in both genera.

The bilaterally disposed featherings or partings situated ventrally on the upper thorax, neck and head run obliquely inwards from the level of the cranial limit of the axilla towards the angle of the mouth. They extend much further forwards than in *Bettongia* so that the divergent interval on each side of the face comes to be situated just behind the angle of the mouth. The reversed flow within the axilla, which originates as in *Bettongia* in the recurvature of the flow on the side of the thorax over

the weakly developed caudal fold of the axilla, is continuous with the feathering in front. However, younger specimens may approach closer to the picture given for *B. penicillata* as there is a possibility that the length attained by the hair has obscured some of the details of its arrangement in tracts.

Elsewhere on the trunk the hair currents follow the primitive plan. No reversal occurs between the scrotum and the cloacal hillock as described in *Bettongia*; the female groin displays no reversals of any kind.



Figs. 36-37.—*Onychogalea fraenata*. Ventral and dorsal views respectively of head, neck and thorax.

Subfamily Macropodinae.

Onychogalea fraenata Gould. Figs. 36–39.

Material.—R.3056—a female (length of head and body about 223 mm.); bred in Melbourne Zoological Gardens; died 2nd July, 1909.

The hair tracts of this unique specimen are very complex. In view of the necessity to figure from dorsal, lateral and ventral aspects, a minimum of verbal description is submitted.

Head.—There are three intervals on each side of the head—(*a*) a divergent interval in front of the medial canthus, (*b*) a divergent interval midway between the eye and the base of the ear, and (*c*) a convergent interval on the lateral border of the interramal zone just behind the level of the medial canthus. In front of the divergent interval *a* the current on the bridge of the nose recurves to produce a reversal that is carried forward on to the rhinarium. Along the crown a convergent hair line conspicuously indicated by a hair-ridge extends from about the level of the divergent interval *b* forward to the level of the divergent interval *a*. A convergent centre, not very clearly defined, is placed approximately over the side of the mandible at the level of the lateral canthus. Both the convergent centre and the convergent interval *c* are on a weakly developed convergent hair line that runs from the base of the ear diagonally across the face to the mid-ventral line at the caudal margin of the submental zone. The presence of these two structures involves changes in direction of the hair streams (Figs. 36 and 38).

Neck.—a counter-clockwise whorl is situated mid-dorsally on the neck immediately behind the occiput. On the side of the neck somewhat below the level of the mid-lateral line, a convergent ridge occurs where the currents flowing over the side of the neck from the nuchal whorl meet those of the ventral neck that flow with a general cranial and lateral inclination from the upper thorax; a convergent interval occurs on it at about

Figs. 38-39.—*Onychogalea fraenata*. 38. Lateral view of whole animal. 39. The groin.

the middle of the neck. Cranially this ridge extends almost to the convergent point on the side of the face; caudally it proceeds over the shoulder and on to the upper arm on which it runs just lateral of and parallel with the preaxial border almost to the flexure of the elbow. Its dorsal component at the caudal end is contributed by the recurved flow from the outer surface of the caudal axillary fold.

Trunk.—Other than in the inguinal region the distribution of the currents on the trunk is largely determined by the presence of whorls (clockwise on the right, counter-clockwise on the left) within the axilla. The whorled systems give rise in front to the reversed stream on the upper thorax and neck that recurves in its lateral portions over the root of the neck, shoulder and arm to participate in the hair-ridge at the side of the neck as described above, and behind to a current that sweeps caudally and laterally across the axilla and recurves on to the side of the body over the axillary fold and the flank just caudal of it. This recurved field is distributed on the trunk, shoulder and upper arm as illustrated in Fig. 38; where it meets the caudally flowing current from the mid-dorsal nuchal whorl a divergent interval occurs on each side situated over about the middle of the scapula and just within its vertebral border.

The tracts of the inguinal region are complex and show considerable asymmetry; they are delineated in Fig. 39. The recurvature of the current on the buttocks on to the postaxial aspect of the thigh involves a centripetal coil reminiscent of that recorded as occurring on the left side of *Wallabia bicolor* (Boardman, 1943*b*), but differing in the constitution of the surrounding fields (Fig. 38).

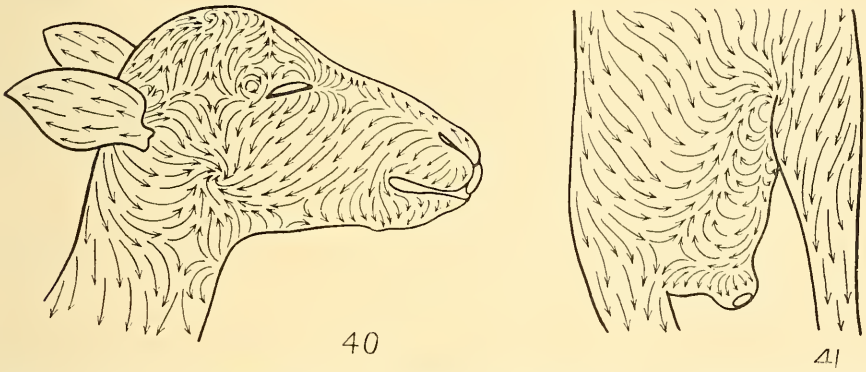
Limbs.—The fore-limb presents no unusual features. The hind-limb has a pair of whorls on the distal portion of the shank similar to those described in *Thylogale* sp. (Boardman, 1943*b*).

Wallabia agilis Gould. Figs. 40 and 41.

Material.—R.13138—a female (length of head and body about 305 mm.); E. Alligator River, Northern Territory; 11th July, 1912.

Head.—On the whole, the head resembles that of *Onychogalea fraenata* (*v. supra*) but differs in having a convergent centre (whorled counter-clockwise) on the crown in place of the extensive hair-ridge recorded in that species and in possessing a small whorl with its centre immediately behind and just above the lateral angle of the eye. The left side of the head shows differences from the right; these appear to be artefacts.

Neck.—Ventro-laterally on the neck at about the middle of its length a convergent interval is present; it is associated with only a very short hair-ridge in front and behind, but this may be due to the fact that the fur is not far developed in this the only specimen available. The nuchal whorl is clockwise; it is situated just caudal of the occiput and has its central portion longitudinally elongate. Ventrally on the neck the hair reversal is the same as in *Onychogalea*.



Figs. 40 and 41.—*Wallabia agilis*. 40. Lateral view of head. 41. Lateral view of hind end of body.

Trunk.—The hair tracts of the trunk are similar to those of *W. bicolor* (*v. infra* and Boardman, 1943*b*) with the proviso that, owing to extensive damage to the inguinal region, it is not possible to give an account of that part other than to say that it appears to be laid down along similar lines. The recurvature over the buttocks on to the postaxial aspect of the thigh shows less complications than in *bicolor*; there are not present any supernumerary ridges or whorls, and there is no asymmetry between the right and left limbs in the disposition of the tracts (Fig. 41).

Wallabia bicolor Desmarest.

Under this name in a previous contribution (Boardman, 1943*b*) a single male specimen (930 part—Australian Museum Collection) was examined. The opportunity to record further members of the subfamily including other species of the genus calls for supplementary details.

Head and Neck.—The hair tracts of the head resemble the condition in *Onychogalea fraenata* (*v. supra*) more than the condition in *Thylogale* sp. The convergent centre on the crown has behind and continuous with it a short hair-ridge where the converging

streams on the crown meet at the mid-dorsal line behind the centre. The hair-ridge running obliquely across the face from the base of the ear terminates somewhat further behind the interramal papilla than in *agilis*; as in *agilis* the ridge is practically non-existent below the convergent interval. The specimen shows the convergent interval on the side of the neck particularly well.

Trunk.—Like *Onychogalea fraenata* the arrangement on the ventral thorax, neck and throat is caused by a divergent centre in each axilla which does not, in this species, show any tendency to be whorled. From the centre a stream flows caudally and laterally over the free border of the caudal fold of the axilla on to its lateral surface where it encounters the caudal and ventral flow over the side of the thorax and forms with it a convergent interval.

The presence of a centripetal coil on the left buttock has already been mentioned. The condition occurs on both sides of *W. dorsalis* (*v. infra*).

Wallabia dorsalis Gray.

Material.—M.5391—a male (length of head and body about 295 mm.); North Coast district of New South Wales; coll. Noel Burnet, 22nd September, 1933 (Australian Museum Collection).

The hair characters of the head and neck are practically identical with those of *bicolor* (*v. supra*) except that the nuchal whorled system is bilaterally doubled. The left member of the pair is more cranially situated than that on the right side and is also larger. The left whorl is counter-clockwise, the right clockwise. A short hair-ridge with an imperfectly formed convergent interval occurs in the mid-dorsal line behind the right whorl.

On the trunk and limbs generally, no significant differences from *bicolor* could be defined. Although the inguinal region is extensively damaged by incision and folding, there seems to be close agreement with the account and figure given for *bicolor* (Boardman, 1943*b*, Fig. 25). The centripetal coil recorded as occurring on the left buttock of *bicolor* is present on both sides in *dorsalis*.

Wallabia sp.

Material.—993—a male (length of head and body 230 mm.); South-Eastern Queensland (Australian Museum Collection).

The specimen shows no differences except in detail from the accounts given of other members of the genus. As in *dorsalis* (*v. supra*) a bilateral pair of whorls occurs dorsally, but in this species they are somewhat in front of the cranial limit of the ear base, and are, therefore, more accurately described as occipital whorls. The whorls are symmetrical for size and position; that on the left is counter-clockwise, that on the right clockwise and there is the usual short ridge and convergent interval between them on the mid-dorsal line. The convergent point on the crown is well developed and shows a tendency to clockwise whorling.

While the tract arrangement on the side of the face is that of a *Wallabia* as at present known, it is of specific interest that the convergent centre on the side of the face is replaced by a centripetal whorl. The convergent interval on the side of the neck is further forward than usual and is separated from the whorl on the face by only a short distance.

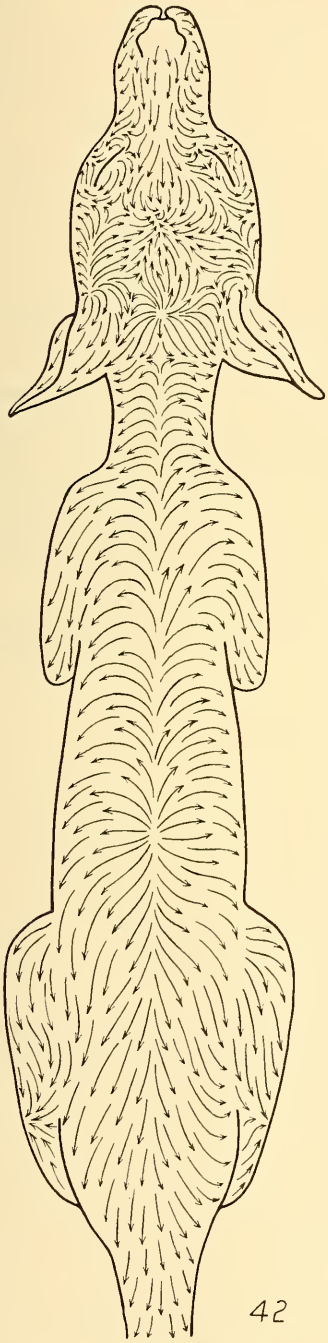
Osphranter robustus Gould.

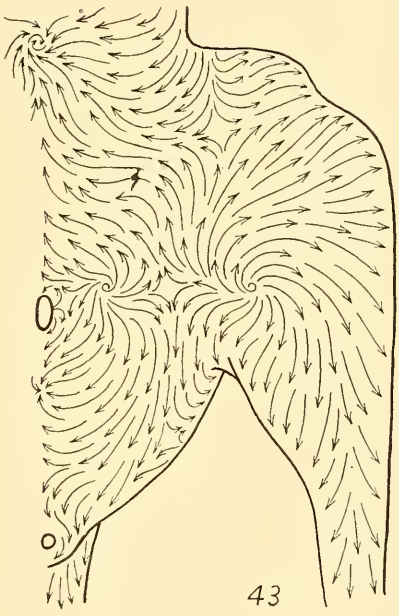
In the specimen of *Osphranter robustus* that formed the subject of the previous communication on the species (Boardman, 1943*b*), it should be added that the convergent interval on the side of the neck is ventrolaterally placed on the root of the neck immediately in front of the shoulder. In this respect *Osphranter robustus* approaches closer to the conditions described for *Thylogale* sp. than any other of the Macropodinae described herein.

MACROPUS MAJOR Shaw. Figs. 42 and 43.

Material.—R.1531—a young male (length of head and body 400 mm.); Victoria; 9th July, 1906.

Head.—The head has the hairs arranged on the plan set down for *Thylogale* sp. (Boardman, 1943*b*). There is a convergent interval above the medial angle of the





Figs. 42 and 43.—*Macropus major*. 42. Dorsal view of whole animal. 43. The groin.

eye and immediately in front of the supraorbital papilla. The divergent interval situated between the eye and the ear occurs about opposite the middle of the base of the ear but above the level of the lateral angle. The convergent centre on the crown has a slight tendency to be whorled in a clockwise fashion. A divergent centre is situated between the ears; just in front of its level on the dorsum of the head and medial of the uppermost limit of the base of the ears, the hairs flowing cranially and laterally from the centre meet an upward flow from the front of the base of the ear to produce a convergent interval. The stream sweeping round from behind the ear forms with the current on the face a convergent ridge which runs obliquely across the angle of the mandible towards the mid-ventral line; the identity of this ridge is, however, lost over the angle of the mandible. Formation of a mid-dorsal occipital divergent interval will be considered below.

Neck and Trunk.—*Macropus major* has a divergent centre in the mid-dorsal line at about the centre of the back. From it a parting extends along the middle line cranially to a position approximately above the occipital region of the skull at which level the backward flowing current from the divergent centre between the ears is encountered and a divergent interval produced. Caudally from the mid-back divergent centre a similar feathering occurs and this persists to about the cranial limit of the ilium. The normal direction of hair on the side of the trunk is not greatly affected by the reversal mid-dorsally.

As in *Thylogale* sp. the arrangement of the tracts on the ventral thorax is dependent on the presence of bilaterally arranged centres of dispersal, in this case, in the form of whorls on the medial aspect of the upper arm somewhat distal of the middle of the humerus; on the left arm the whorl is clockwise, on the right counter-clockwise. At the root of the neck in front of and slightly ventral of the shoulder, a convergent interval is formed similar to that shown as a somewhat imperfect structure in *Thylogale* (Boardman, 1943*b*, Fig. 24).

Tract disposition in the inguinal region is charted in Fig. 43.

Limbs.—Except for the presence of the whorl described above on the medial aspect of the upper arm, both fore- and hind-limbs may be said to have the primitive arrangement.

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EXPLANATION OF PLATE VIII.

Pseudocheirus convolutor convolutor. The groin of the Pearson Collection male drawn to show the relationships between hair arrangement and the scrotum and its pouch.